AN ADJUSTABLE IRIS-DIAPHRAGM CONTROLLER

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority of Taiwanese application no. 092128593, filed on October 15, 2003.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to an adjustable iris-diaphragm controller, more particularly to an adjustable iris-diaphragm controller with a control module for controlling a brushless direct current motor to adjust an aperture defined by an iris.

2. Description of the Related Art

Figure 1 illustrates a known arrangement of a brushless direct current (DC) motor 21, and a Hall sensor (H). The DC motor 21 has a rotor (R), and a stator (S) surrounding the rotor (R). The Hall sensor (H) detects the angular position of the rotor (R) of the DC motor 21, and is disposed adjacent to the rotor (R). First and second transistors (Q1, Q2) are coupled electrically to the Hall sensor (H) and the stator (S).

In operation, when the south pole of the rotor (R) is proximate to the Hall sensor (H), the Hall sensor (H) generates a relatively large output voltage sufficient to activate the first transistor (Q1). The activation of the first transistor (Q1) causes the flow of current (i1) through the stator (S), which results in counterclockwise rotation of the rotor (R). On the

other hand, when the north pole of the rotor (R) is proximate to the Hall sensor (H), the Hall sensor (H) generates a relatively large output voltage sufficient to activate the second transistor (Q2). The activation of the second transistor (Q2) causes the flow of current (i2) through the stator (S) to permit further counterclockwise rotation of the rotor (R).

It is known to employ DC motors, such as stepper and servo motors, to adjust an aperture defined by an iris in an adjustable iris-diaphragm controller. However, these types of DC motors are relatively expensive to implement and require complicated control circuitry.

To the applicant's knowledge, conventional adjustable iris-diaphragm controllers do not use a brushless DC motor due to the lack of an appropriate control module that is relatively inexpensive and that is capable of controlling the brushless DC motor to adjust the aperture defined by the iris to a desired setting within a relatively short period of time.

SUMMARY OF THE INVENTION

Therefore, the object of the present invention is to provide an adjustable iris-diaphragm controller with a control module for controlling a brushless direct current motor to adjust an aperture defined by an iris.

According to the present invention, an adjustable iris-diaphragm controller comprises an aperture-defining unit, a Hall sensor, an

aperture-setting unit, a current source, and a control module. The aperture-defining unit includes a brushless direct current (DC) motor, and an iris coupled to and associated operably with the DC motor for defining an aperture that corresponds to an angular position of the DC motor. The Hall sensor is coupled to and is associated operably with the DC motor so as to detect the angular position of the DC motor and to provide a first output voltage corresponding to the angular position detected thereby. The aperture-setting unit is operable so as to set a reference aperture and to provide a second output voltage corresponding to the reference aperture. The current source serves to supply electric current. The control module includes a differential circuit, an integrator, and a current-limiting circuit. The differential circuit is coupled electrically to the Hall sensor and the aperture-setting unit, receives the first and second output voltages, and provides a third output voltage corresponding to the first and second output voltages. The integrator is coupled electrically to the differential circuit, receives the third output voltage, and provides a control output signal corresponding to the third output voltage. The current-limiting circuit is coupled electrically to the DC motor, the integrator, and the current source. The current-limiting circuit receives the control output signal, and limits supply of the electric current from the current source to the

DC motor in accordance with the control output signal for adjusting rotational speed of the DC motor.

When the DC motor is rotated to an angular position corresponding to the reference aperture, the current-limiting circuit inhibits the supply of the electric current from the current source to stop further rotation of the DC motor. Accordingly, the aperture defined by the iris is maintained at the reference aperture.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the present invention will become apparent in the following detailed description of the preferred embodiments with reference to the accompanying drawings, of which:

Figure 1 is a schematic circuit diagram to illustrate a known arrangement of a brushless direct current motor and a Hall sensor;

Figure 2 is a schematic circuit block diagram of the first preferred embodiment of an adjustable iris-diaphragm controller according to the present invention;

Figure 3 is a schematic electrical circuit diagram of the first preferred embodiment;

Figure 4 is an exploded perspective view to illustrate an aperture-defining unit of the first preferred embodiment;

Figure 5 is a schematic perspective view of the

aperture-defining unit in an assembled state;

Figure 6 is a schematic electrical circuit diagram of an aperture-setting unit of the first preferred embodiment; and

Figure 7 is a schematic electrical circuit diagram of an aperture-setting unit of the second preferred embodiment of an adjustable iris-diaphragm controller according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figures 2 and 3, the first preferred embodiment of an adjustable iris-diaphragm controller 100 according to this invention is shown to include an aperture-defining unit 2, a Hall sensor 4, an aperture-setting unit 3, a current source 5, and a control module 1.

The aperture-defining unit 2 includes a brushless direct current (DC) motor 21, and an iris 22 coupled to and associated operably with the DC motor 21. In this embodiment, the iris 22 defines an aperture 223 (see Figure 5) that corresponds to an angular position of the DC motor 21.

In particular, with further reference to Figures 4 and 5, the adjustable iris-diaphragm controller 100 further includes a housing wall 6 that has opposite first and second surfaces (F, R), a left portion formed with upper and lower curved slots 61, 62 extending through the first and second surfaces (F, R), and a right portion

formed with a through hole 63 extending through the first and second surfaces (F, R). The DC motor 21 is disposed on the first surface (F) of the housing wall 6, and includes a crank 211. The crank 211 has first and second ends that extend respectively through the upper and lower curved slots 61, 62 in the left portion of the housing wall 6, and a middle portion that is disposed between the first and second ends and that is coupled co-rotatably to a shaft (not shown) of the DC motor 21. The iris 22 is disposed slidably on the second surface (R) of the housing wall 6, and includes first and second iris leaves 221, 222, each of which has left and right portions. The left portion of each of the first and second iris leaves 221, 222 is connected pivotally to a respective one of the first and second ends of the crank 211 of the DC motor 21. The right portions of the first and second iris leaves 221, 222 overlap to form the aperture 223 that is aligned with the through hole 63 in the right portion of the housing wall 6. Accordingly, rotation of the DC motor 21 in a first direction results in leftward movement of the first iris leaf 221 and in rightward movement of the second iris leaf 222, whereas rotation of the DC motor 21 in a second direction opposite to the first direction results in rightward movement of the first iris leaf 221 and in leftward movement of the second iris leaf 222, thereby adjusting the aperture 223 defined by the iris 22.

Referring again to Figures 2 and 3, the Hall sensor 4 is coupled to and is associated operably with the DC motor 21, detects the angular position of the DC motor 21, and provides a first output voltage corresponding to the angular position detected thereby. Since the cooperative action of the DC motor 21 and the Hall sensor 4 is well-known in the art, a detailed description of the same is dispensed with herein for the sake of brevity.

With further reference to Figure 6, the aperture-setting unit 3 is operable so as to set a reference aperture and to provide a second output voltage corresponding to the reference aperture. In this embodiment, as best shown in Figure 6, the aperture-setting unit 3 is a manually operated mechanism that includes a voltage source 311, a plurality of resistors 312, and a manually operable switch 313. Each of the resistors 312 is coupled to the voltage source 311, has an electrical resistance distinct from those of the other ones of the resistors 312, and provides a corresponding voltage drop thereat. The voltage drops of the resistors 312 correspond respectively to predetermined reference apertures. The manually operable switch 313 serves to couple a selected one of the resistors 312 to the control module 1 so that the voltage drop at the selected one of the resistors 312 serves as the second output voltage. The switch 313 is preferably a multi-way switch that includes a first

terminal 3131 coupled to the control module 1, a plurality of second terminals 3132 coupled respectively to the resistors 312, and a switch knob 3133 operable so as to connect electrically and selectively one of the second terminals 3132 to the first terminal 3131.

The current source 5 serves to supply electric current.

As best shown in Figures 2 and 3, the control module 1 is used to control the aperture-defining unit 2, and includes a differential circuit 10, an integrator 13, and a current limiting circuit 14. In particular, the differential circuit 10 is coupled electrically to the Hall sensor 4 and the aperture-setting unit 3, receives the first and second output voltages therefrom, and provides a third output voltage corresponding to the first and second output voltages. More particularly, the differential circuit 10 includes first and second differential amplifiers 11, 12. The first differential amplifier 11 is coupled to the Hall sensor 4 and is operable so as to receive and amplify the first output voltage. It is noted that the first differential amplifier 11 amplifies the first output voltage by a factor of ten. As such, sensitivity of the control module 1 is enhanced substantially. The second differential amplifier 12 is coupled to the first differential amplifier 11 and the aperture-setting unit 3, and is operable so as to amplify a difference between the first

output voltage amplified by the first differential amplifier 11 and the second output voltage from the aperture-setting unit 3 for producing the third output voltage. In an alternative embodiment, the first differential amplifier 11 may be dispensed with. As a consequence, the second differential amplifier 12 is coupled directly to the Hall sensor 4 to receive the first output voltage.

The integrator 13 is coupled electrically to the second differential amplifier 12 of the differential circuit 10, receives the third output voltage, and provides a control output signal corresponding to the third output voltage. It is noted that the integrator 13 converts the third output voltage, which is a square wave, to the control output signal, which is a triangular wave. As such, the DC motor 21 can be controlled with a high degree of precision and accuracy.

The current-limiting circuit 14 is coupled electrically to the DC motor 21, the integrator 13, and the current source 5. In this embodiment, the current-limiting circuit 14 receives the control output signal, and limits supply of the electric current from the current source 5 to the DC motor 21 in accordance with the control output signal for adjusting rotational speed of the DC motor 21. In particular, the current-limiting circuit 14 includes a variable impedance component, preferably a bipolar junction

transistor (Q3). The transistor (Q3) has a base terminal 141 coupled to the integrator 13, a collector terminal 142 coupled to the current source 5, and an emitter terminal 143 coupled to the DC motor 21.

In operation, when the aperture setting unit 3 is set at a reference aperture such that the third output voltage of the second differential amplifier 12, which corresponds to the difference between the first and second output voltages, is not zero, the control output signal of the integrator 13 drives rotation of the DC motor 21. As the DC motor 21 rotates, the third output voltage approaches zero. Consequently, the rotational speed of the DC motor 21 is decelerated. When the DC motor 21 is rotated to an angular position corresponding to the reference aperture, that is, when the third output voltage is equal to zero, the current-limiting circuit 14 inhibits the supply of the electric current from the current source 5 to stop further rotation of the DC motor 21. Accordingly, the aperture 223 defined by the iris 22 is maintained at the reference aperture.

Referring to Figure 7, the aperture-setting unit 3' of the second preferred embodiment of an adjustable iris-diaphragm controller 100 according to the present invention is shown to include an automatically operated mechanism that includes a processor 314. In this embodiment, the processor 314 receives and processes an input brightness signal (P1), and provides an output

signal that corresponds to the brightness signal (P1). The automatically operated mechanism further includes a differential amplifier 315 that is coupled to the processor 314 and the control module 1, that receives the output signal of the processor 314, and that provides an output voltage corresponding to the output signal of the processor 314. The output voltage of the differential amplifier 315 serves as the second output voltage.

It has thus been shown that the adjustable iris-diaphragm controller 100 of this invention includes a control module that is relatively inexpensive to implement and that permits the use of brushless DC motor 21 for accurate control of the aperture 223 defined by the iris 22.

While the present invention has been described in connection with what is considered the most practical and preferred embodiments, it is understood that this invention is not limited to the disclosed embodiments but is intended to cover various arrangements included within the spirit and scope of the broadest interpretation so as to encompass all such modifications and equivalent arrangements.